

**Savannah River Site
Solid Waste Management Department
Consolidated Incinerator Facility
Operator Training Program**

AIR AND NITROGEN SYSTEMS (U)

Study Guide

ZIOITX19

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REVISION LOG

REV.	AFFECTED SECTION(S)	SUMMARY OF CHANGE
00	All	New Issue
01	All	Format, design modifications and changes to instrument and alarm setpoint index
02	All	Format, comment resolution, system design description modifications

TABLE OF CONTENTS

REFERENCES.....	6
LIST OF FIGURES.....	7
LIST OF TABLES	8
LEARNING OBJECTIVES	9
SYSTEM OVERVIEW	
Safety.....	12
SYSTEM PURPOSE	
Introduction	13
System Purpose	13
DESCRIPTION AND FLOWPATH	
Air Systems	15
Plant Air System	15
Instrument Air System	18
Breathing Air System	20
Nitrogen System.....	22
Compressors and Air Dryers	25
Summary	27
MAJOR COMPONENTS	
Plant and Instrument Air Compressors	28
Breathing Air Compressor	30
Air Dryers.....	30
Breathing Air Receiver.....	32
Nitrogen Tank	33
Nitrogen Ambient Air Vaporizer	33
Nitrogen Economizer	33
Summary	34

TABLE OF CONTENTS (Cont.)

INSTRUMENTATION

Plant Air Pressure Instrumentation	35
Instrument Air Pressure Instrumentation	35
Breathing Air Instrumentation	35
Compressor Instrumentation	40
Air Dryer Instrumentation	41
Nitrogen System Instrumentation	42
Summary	43

CONTROLS, INTERLOCKS, AND LIMITS

Controls	44
Interlocks	46
Limits	47
Summary	48

SYSTEM INTERRELATIONS

Plant Air System	49
Instrument Air System	49
Breathing Air System	49
Nitrogen System	50
Summary	50

INTEGRATED PLANT OPERATIONS

Normal Operations	51
Abnormal Operations	53
Summary	57

REFERENCES

1. WSRC- SA-17, *Safety Analysis Report, 200-H Area, Consolidated Incineration Facility*, DOE Approval Copy, December 1994
2. WSRC Solid Waste Training, System Design Description, ZIOISX19, *Air and Nitrogen Systems*, Rev. 0
3. CIF System Operating Procedure 261-SOP-PA/IA-01, *Plant Air/Instrument Air (U)*, Approval Date 10/27/95, Rev. 2
4. CIF System Operating Procedure 261-SOP-PA/IA-02, *Operation Of Portable Air Compressor (U)*, Approval Date 11/15/95, Rev. 0
5. CIF System Operating Procedure 261-SOP-BA-01, *Breathing Air (U)*, Approval Date 05/26/95, Rev. 0
6. CIF System Operating Procedure 261-SOP-LN-01, *Liquid Nitrogen Supply (U)*, Approval Date 10/26/95, Rev. 3
7. CIF Abnormal Operating Procedure 261-AOP-PA-01, *Plant Air Events (U)*, Approval Date 05/26/95, Rev. 0
8. CIF Abnormal Operating Procedure 261-AOP-BA-01, *Breathing Air Events (U)*, Approval Date 05/13/95, Rev. 0
9. CIF Abnormal Operating Procedure 261-AOP-NS-01, *Nitrogen Events (U)*, Approval Date 09/22/95, Rev. 0
10. Drawing W830330, *Building 262-H Nitrogen System P&ID.*, Rev. 17
11. Drawing W830332, *Building 261-H Plant Air System P&ID.*, Rev. 17
12. Drawing W830333, *Building 261-H Breathing Air System Sh. 1 P&ID.*, Rev. 23
13. Drawing W830336, *Building 262-H Breathing Air System Sh. 3 P&ID.*, Rev. 11
14. Drawing W830343, *Building 261-H Breathing Air System Sh. 2 P&ID.*, Rev. 17
15. Drawing W830350, *Building 261-H Instrument Air System P&ID.*, Rev. 14
16. Drawing M-M6-H-9040, *Building 261-H CIF Plant Air/Instrument Air System P&ID (U)*, Rev. 1
17. Drawing M-M6-H-9041, *Building 261-H CIF Breathing Air System P&ID (U)*, Rev. 1

18. Drawing M-M6-H-9042, *Building 261-H CIF Instrument Air Dryer P&ID (U)*, Rev. 1

LIST OF FIGURES

1. Plant Air System.....	16
2. Instrument Air System.....	18
3. Breathing Air System	20
4. Nitrogen System	23
5. Plant and Instrument Air Compressors and Dryer	29
6. Breathing Air Compressor and Dryer.....	31
7. Breathing Station and Local Alarm Panel	36

LIST OF TABLES

1. Plant Air Requirements and Peak Usage..... 17

2. Instrument Air Requirements and Peak Usage..... 19

3. Breathing Air Instrument Alarms..... 38

4. Breathing Air Stations and Local Panels..... 39

5. Compressors Alarm and Control Panels 40

6. Air Compressor Limits..... 47

LEARNING OBJECTIVES

TERMINAL OBJECTIVE

- 1.0** Without references, **EXPLAIN** the significance of the Air and Nitrogen Systems to Consolidated Incinerator Facility operations, including their importance to safety, and the impact on operations of a failure of the systems.

ENABLING LEARNING OBJECTIVES

- 1.1** **STATE** the personnel safety concerns associated with Air and Nitrogen Systems.
- 1.2** **STATE** the purpose of the Air and Nitrogen Systems.
- 1.3** **EXPLAIN** the consequences of a failure of the Air and Nitrogen Systems to fulfill their intended purposes, including the effects on other systems or components, overall plant operation, and safety.

TERMINAL OBJECTIVE

- 2.0** Using system diagrams, **DESCRIBE** the normal Air and Nitrogen Systems flowpaths to determine their significance on overall system operation and their relationship to other facility systems.

ENABLING LEARNING OBJECTIVES

- 2.1** **DESCRIBE** the Air and Nitrogen Systems arrangement to include a drawing showing the system components and interfaces with other systems.
- 2.2** **DESCRIBE** the physical layout of the Air Systems components including, the general location, how many there are, and functional relationship for each of the following major components:
- a. Plant/Instrument Air Compressors and Dryers
 - b. Breathing Air Compressor and Dryers

TERMINAL OBJECTIVE

- 3.0** Given Air and Nitrogen Systems operation parameters, **EVALUATE** potential problems that could effect the normal functioning of the systems or their components to determine the significance of the existing condition and the actions required to return the systems to normal operation.

LEARNING OBJECTIVES (Cont.)

ENABLING LEARNING OBJECTIVES

- 3.1** **DESCRIBE** the following major components of the Air and Nitrogen Systems including their functions, principles of operation, and basic construction:
- a. Plant and Instrument Air Compressors
 - b. Breathing Air Compressor
 - c. Air Dryers
 - d. Breathing Air Receiver
 - e. Nitrogen Storage Tank
 - f. Nitrogen Ambient Air Vaporizer
 - g. Nitrogen Economizer
- 3.2** **DESCRIBE** the following Air and Nitrogen Systems instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls.
- a. Plant Air System
 - b. Instrument Air System
 - c. Breathing Air System
 - d. Air Compressors
 - e. Air Dryers
 - f. Nitrogen System
- 3.3** **EXPLAIN** how the following Air and Nitrogen Systems equipment are controlled in all operating modes or conditions to include: control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on component operation.
- a. Air Compressors
 - b. Air Dryers
 - c. Nitrogen System
- 3.4** **DESCRIBE** the interlocks associated with the Air and Nitrogen Systems equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary.
- a. Instrument Air System
 - b. Air Compressors
 - c. Nitrogen System

LEARNING OBJECTIVES (Cont.)

- 3.5** **STATE** the limits for the following Air and Nitrogen Systems and major components:
- a. Plant and Instrument Air Compressors
 - b. Breathing Air Compressor
 - c. Air Dryers
 - d. Breathing Air Receiver
 - e. Nitrogen System

TERMINAL OBJECTIVE

- 4.0** Given necessary procedures or other technical documents and system conditions, **DETERMINE** the operator actions required for normal and off normal operation of the Air and Nitrogen Systems including problem recognition and resolution.

ENABLING LEARNING OBJECTIVES

- 4.1** Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following Air and Nitrogen Systems operations:
- a. Mode 1 Operations
 - b. Mode 2 Operations
 - c. Mode 3 Operations
- 4.2** Given a description of abnormal equipment status for Air and Nitrogen Systems, **EXPLAIN** the significance of the condition on system operation.
- 4.3** Given a description of the Air and Nitrogen Systems equipment status, **STATE** any corrective actions required to return system operation to a normal condition.
- 4.4** **DETERMINE** the effects on the Air and Nitrogen Systems and the integrated plant response when given any of the following:
- a. Indications/alarms
 - b. Malfunctions/failure of components

SYSTEM OVERVIEW

Air has a variety of uses in industrial processes ranging from control and operation of pneumatic components to operation of air driven tools. At the CIF, air is used for pneumatic control of valves, dampers, positioners, instruments and for portable breathing equipment. Based upon these uses, the air delivered to the processes needs to be reliable, filtered, and pressurized.

Nitrogen is an inert gas that is used throughout commercial industries. The inert nature of nitrogen is beneficial in many processes where air or oxygen need to be displaced. Displacement of air and oxygen is done to prevent corrosion, combustion, and reactions. At CIF, nitrogen is used to displace oxygen in the liquid waste storage tanks and for fire suppression. Nitrogen also provides purging for liquids in piping systems as well as a backup supply for air in pneumatically controlled and operated equipment.

Safety

E.O. 1.1	STATE the personnel safety concerns associated with Air and Nitrogen Systems.
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The operation of support systems have many aspects related to safety. Personnel operating or in the vicinity of operating Air and Nitrogen Systems or components should always take the following precautions:

- Be aware of operating valves or breaking lines in pressurized systems to prevent damage from high pressure gases and fluids.
- Do not wear chains, necklaces or bracelets in the vicinity of rotating equipment. Long or flowing hair and loose clothing should be tied back or restrained when in the vicinity of rotating equipment.
- Personnel should follow the safety rules and precautions associated with hazardous energy control when operating electrical equipment.
- Always obey posted hearing protection signs and warnings when in the vicinity of noisy or loud equipment.
- Liquid nitrogen is at a very low temperature. Operators should always wear appropriate safety equipment when operating components on liquid nitrogen systems.
- Operators should be aware of the potential for slipping and tripping around liquid nitrogen spills.
- Operators need to be aware of the pinch points around air and nitrogen system components such as instrument cabinets, rotating shafts, etc.

SYSTEM PURPOSE

Introduction

In the CIF, compressed air is supplied throughout the facility to pneumatic equipment, instruments, miscellaneous hose stations, and breathing air stations. The Compressed Air System needs three subsystems because of different requirements: Plant Air, Instrument Air, and Breathing Air. Of these three, Plant air has the "fewest" requirements. In most cases, plant air is acceptable straight from the compressor. Instrument air needs to be filtered and dried to prevent any particulate matter from entering the instrument and to prevent the formation of water in the lines. Breathing air is a life support system which must be free of water, oil, particulate matter and also be maintained at a controlled temperature.

Liquid nitrogen is also used in the facility for several purposes: providing a nitrogen blanket as an inert gas, instrumentation, fire protection (nitrogen snuffing), pressurizing the thermosyphon barrier seals in the Tank Farm, and as a backup for instrument air.

System Purpose

EO 1.2 STATE the purpose of the Air and Nitrogen Systems.

The purpose of the Plant Air System is to satisfy process air requirements to hose stations located throughout the facility. The hose stations have numerous fittings and connections to allow for the operation of air-driven tools and equipment. Plant Air also provides pressurized air to the Offgas System Quench Vessel emergency spray ring, cooling for RK and SCC cameras, and air for the Rad Oils Solvent Unloading Pump.

The purpose of the Instrument Air System is to satisfy air requirements for air-operated valves and other pneumatically operated instruments throughout the facility. Instrument air will be clean, free of water, oil and dust, and it will have a steady pressure and a reliable source of supply. The system capacity will be at least 10% greater than anticipated loads.

The purpose of the Breathing Air System is to provide filtered and regulated breathing air to self-contained breathing apparatuses for respiratory protection to protect employees working in areas that are potentially radioactive or chemically contaminated. The breathing air compressor is part of an independent system meeting Occupational Safety and Health Administration (OSHA) breathing air requirements.

The purpose of the Nitrogen System is to receive and store liquid nitrogen and to provide gaseous nitrogen for inert blanketing of liquid contents in waste tanks, purging of liquid and fuel lines, and to provide a backup supply for the Instrument Air System.

E.O. 1.3	EXPLAIN the consequences of a failure of the Air and Nitrogen Systems to fulfill their intended purposes, including the effects on other systems or components, overall plant operation, and safety.
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If the facility did not receive the required amount of Plant Air at the desired pressure, the primary concern would be a loss of purging air to the emergency spray ring on the Offgas System Quench Vessel. If the facility did not receive the required amount of Instrument Air pressure, a shutdown would occur at 75 psig. This is due to the fact that the pneumatic controls would not be able to adjust to plant transients. If the facility did not receive the required amount of Breathing Air pressure, no work in potentially contaminated areas could be performed. If the facility did not receive the required amount of nitrogen, inert blanketing on the liquid waste tanks in the Tank Farm would be lost and the facility would have to be shut down. This would be done as a safety concern because nitrogen is used to prevent or mitigate exothermic reactions in the liquid waste tanks. If the nitrogen supply in the six bottles used for fire suppression in the Solid Waste Feed System housings was lost, solid waste feed to the incinerator would cease. This is done to prevent the possibility of a box of solid waste burning in the housings.

Summary

- The Plant Air System supplies air for the operation of pneumatic equipment
- The Instrument Air System provides oil-free, dry air for the operation of instruments and pneumatic components.
- The Breathing Air System provides filtered and regulated air for respiratory protection to protect employees working in potentially contaminated areas.
- The Nitrogen System provides inert blanketing, purging, pressurizing, fire suppression, and Instrument Air backup.

DESCRIPTION AND FLOWPATH

Air Systems

The source of compressed air for the plant, instrument and breathing air in the CIF are three, rotary air cooled screw-type compressors located to the east of the Box Handling Area in Building 261-H. The facility supplies compressed air at 100 pounds per square inch gauge (psig) that is used for plant air and instrument air; compressed air supplied at 120 psig is used for breathing air.

Plant Air System

E.O. 2.1 **DESCRIBE** the Air and Nitrogen Systems arrangement to include a drawing showing the system components and interfaces with other systems.

The Plant Air System distributes process air to the Tank Farm, Offgas Area, Incineration System Ashout/Ashcrete Area, and the Box Handling Areas as shown in Figure 1, *Plant Air System* (Note: Unless otherwise stated, all components associated with the Plant Air System begin with the prefix H-261-PA). The compressed air supply is designed to satisfy plant air requirements of 280 standard cubic feet per minute (scfm). Plant air pressure is routinely displayed and monitored in the Control Room but local indicators are provided at numerous locations along the distribution headers and at regulators for the specific equipment supplied by the system.

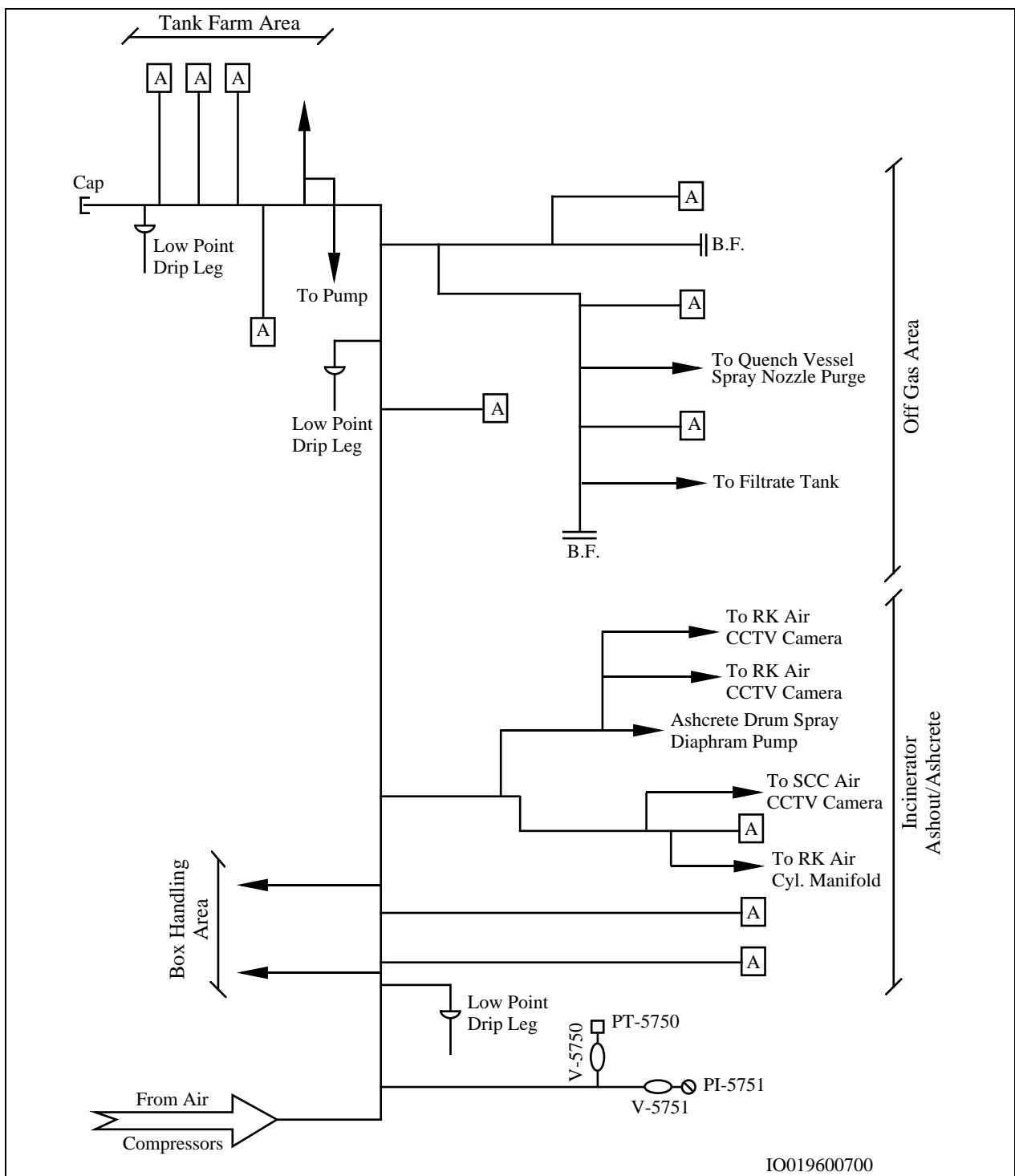


Figure 1 Plant Air System

The plant air requirements are based on peak usage as identified in Table 1, *Plant Air Requirements and Peak Usage*.

Table 1 Plant Air Requirements and Peak Usage

LOAD	USAGE (SCFM)
Air grinders and tools	100
Box Handling equipment	5
Ashcrete diaphragm pump	80
Quench Vessel	5
Ashcrete drum spray diaphragm pump	25
Filter backwash	5
Design development (15%)	34
Extra capacity (10%)	26
TOTAL	280

Plant Air System Flowpath

The Plant Air System supplies air to four (4) main areas in the CIF as shown in Figure 1, *Plant Air System*.

- Air hose stations in the Spare/Blend/and Aqueous Waste Tanks, and at the Regulated Truck Unloading area (Bldg. 262-H)
- Air hose stations in the Offgas Area including the Quench Vessel Spray Nozzle Purge (Bldg. 261-H)
- Air hose stations in the Incinerator/Ashcrete Area including the RK and SCC Air CCTV camera (Bldg. 261-H)
- Box Handling Area (Bldg. 261-H)

The system originates from the Compressed Air Receiver. Supply headers and lines to the main areas are isolated by 2-inch (2") valves. The manifold inlet line from the air compressors enters Building 261-H at the Box Handling Area. At this point, part of the 2" line branches through V-5750 and V-5751 1/2" isolation valves for pressure transmitter PT-5750 and local indicator PI-5751. The transmitter is connected to a low pressure switch and pressure indicator in the Control Room.

Instrument Air System

Plant air will be dried and filtered for use in facility instrumentation. Instrument air, shown in Figure 2, *Instrument Air System*, is supplied to the facility at 100 psig (Note: Unless otherwise stated, all components associated with the Instrument Air System begin with the prefix H-261-IA). The Instrument Air System distributes air to the Tank Farm and to the Offgas, Incineration System/Ashout, and Box Handling Areas. The system also supplies process air to the HEPA filters and building HVAC components. Instrument air is used for air-operated valves (e.g., quench tank water supply) and pneumatically operated instrumentation.

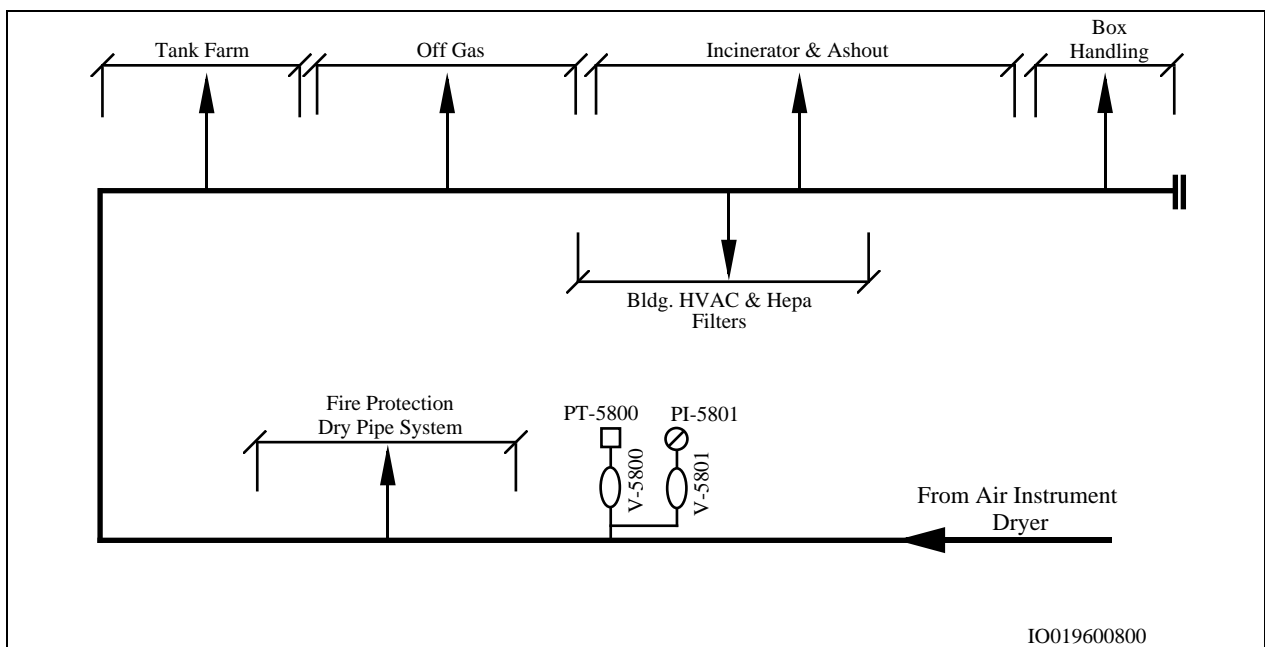


Figure 2 Instrument Air System

Instrument air is also supplied to the three (3) dry-pipe Fire Protection System sprinkler headers at approximately 35 psig for deluge valves and flappers. The compressed air supply is designed to meet instrument air requirements of 130 scfm.

Instrument Air System Flowpath

Instrument air is designated at the point where the 2" header branches from the outlet of the air receiver on the discharge side of the compressors. The header directs air through the dryers and then distributes the filtered and dried air to the following four areas:

- Tank Farm Area (Bldg. 262-H)
- Offgas Area (Bldg. 261-H)
- Incinerator & Ashout Area (Bldg. 261-H)
- Fire Protection Area (Bldg. 261-H & 262-H)
- Bldg. HVAC & HEPA Filters Area (Bldg. 262-H)

The instrument air requirements are based on the following peak usage as identified in Table 2, *Instrument Air Requirements and Peak Usage*.

Table 2 Instrument Air Requirements and Peak Usage

LOAD	USAGE (SCFM)
On-off valves	38
Control valves	8
Miscellaneous I/P transmitters, analyzers and controllers	32
HVAC	25
Design development (15%)	15
Extra capacity (10%)	10
TOTAL	128

The air supply on the 2" main header passes through V-5800 and V-5801, the isolation valve to pressure transmitter PT-5800 and pressure indicator PI-5801. Pressure indication is transmitted to the control room. Supply headers and lines have 1" plugged isolation valves provided every 10 feet for isolation of components.

Breathing Air System

Breathing air is provided to protect employees working in areas that are potentially radioactive or chemically contaminated. The Breathing Air System, shown in Figure 3, *Breathing Air System*, is also utilized during normal maintenance procedures where radioactive or chemical atmospheric conditions exist (Note: Unless otherwise stated, all components associated with the Breathing Air System begin with the prefix H-261-BA). The chemical atmospheric conditions must not exceed the Immediately Dangerous to Life and Health (IDLH) levels. The system is designed to provide six (6) users a 5-minute egress period in the event of failure of source air.

The breathing air compressor is part of an independent system designed to meet OSHA breathing air requirements. Breathing air station manifolds are located throughout the facility. Each breathing air station consists of a filter housing with a 25-micron cartridge filter, a manifold, and four (4) user connections. Each connection is rated for 30 scfm flow and for up to 150 feet of 3/8" breathing air hose. Each station also includes a local alarm panel. Each panel is provided with an annunciator horn and two (2) "loss of air" indicators. The panel also includes an acknowledge switch and a pushbutton test switch to ensure the panel is operational.

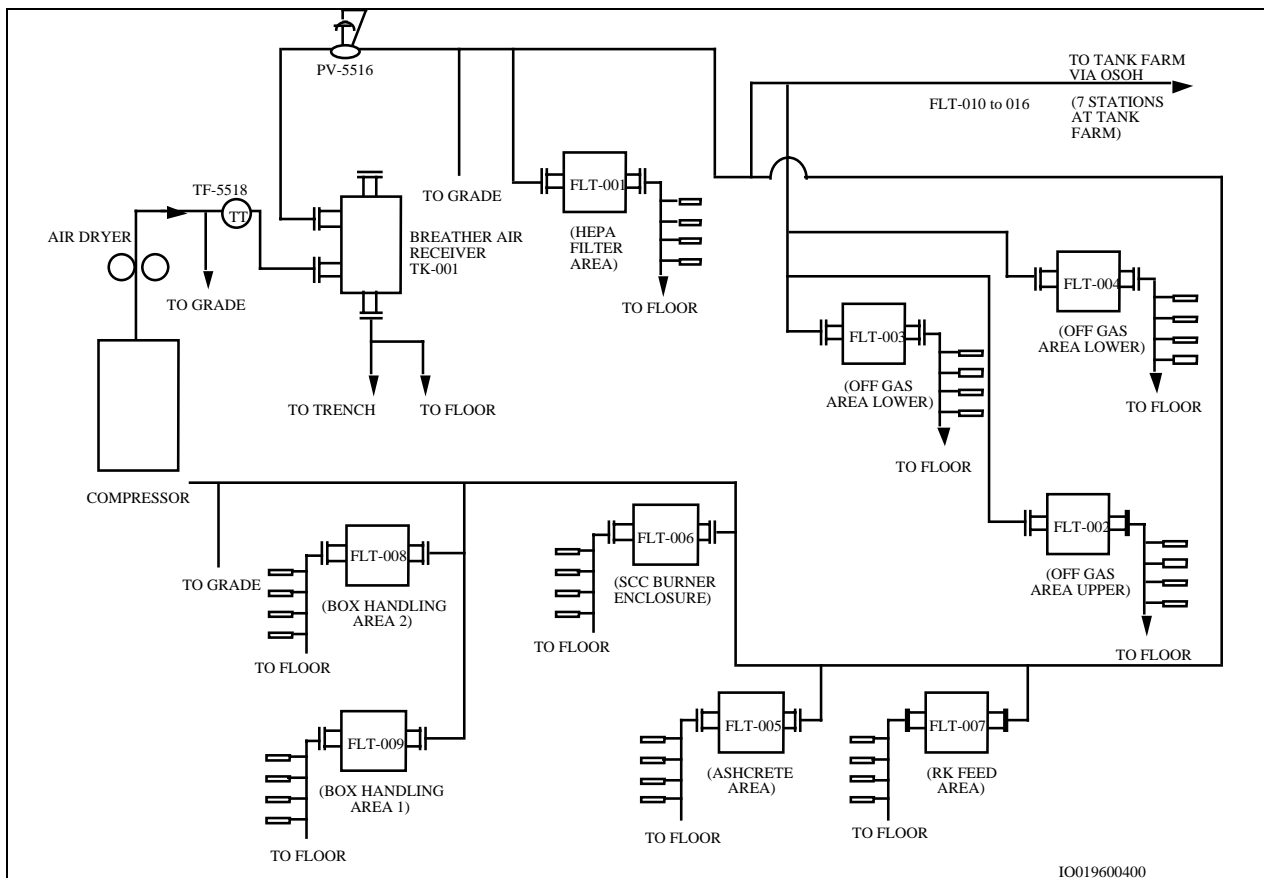


Figure 3 Breathing Air System

Breathing Air System Flowpath

As previously mentioned, the Breathing Air System supplies air to 16 stations throughout the CIF as follows:

- Offgas and HEPA Filter Area - 4 stations (Bldg. 261-H)
- Ashcrete, RK Feed, SCC Burner and Box Handling Area - 5 stations (Bldg. 261-H)
- Tank Farm Area - 7 stations (Bldg. 262-H)

The system originates from the dedicated compressor and dryer arrangement. The compressed air is supplied by a 2" line inlet to the air receiver tank TK-001. Before air enters the tank, it passes through Thermowell Temperature Indicator TI-5518 and Temperature Transmitter TT-5518, which converts resistance to current and sends information to the Control Room. The air enters the tank flowing through an isolation valve V-001 and check valve CV-002. Breathing air leaving TK-001 passes through a 2" pressure reducing valve PV-5516 and then branches off to the main distribution areas. Upstream of PV-5516 air passes by pressure indicator PI-5501 and low pressure switch PSL-5502.

Downstream of PV-5516 a pressure relief valve PSV-002 is provided along with a pressure indicator PI-5503 and a high/low pressure switch PSHL-5504. Indication of pressure is transmitted to the control room for monitoring and alarm. Distribution to the various headers and supply lines in the area normally passes through cartridge filters, pressure indicators and isolation valves before reaching the manifolds.

Nitrogen System

The Nitrogen System receives and stores liquid nitrogen and provides gaseous nitrogen for inert blanketing of liquid contents in waste tanks. The system has a storage tank for receiving and storage of liquid nitrogen when needed for tank nitrogen blankets. The distribution system contains vaporizers and pressure regulators for changing the state of the liquid nitrogen to a gaseous form and for distribution to the waste tanks (See Figure 4, *Nitrogen System*). (Note: Unless otherwise stated, all components associated with the Nitrogen System begin with the prefix H-262-LN).

Nitrogen is provided in the Tank Farm for the following functions:

- Automatically purge the ROW System at the end of a pumping mode.
- Automatically purge the ROW System in the event of a power failure to the Defense Waste Processing Facility (DWPF) ROW Transfer Pump
- Provide an inert blanket above the liquids in the four liquid waste tanks
- Provide an inert gas for the Fuel Oil Tank level transmitter
- Purge lines or equipment at hose stations
- Provide backup for Instrument Air System
- Provide pressurization of the barrier seal thermosyphons on liquid waste pumps

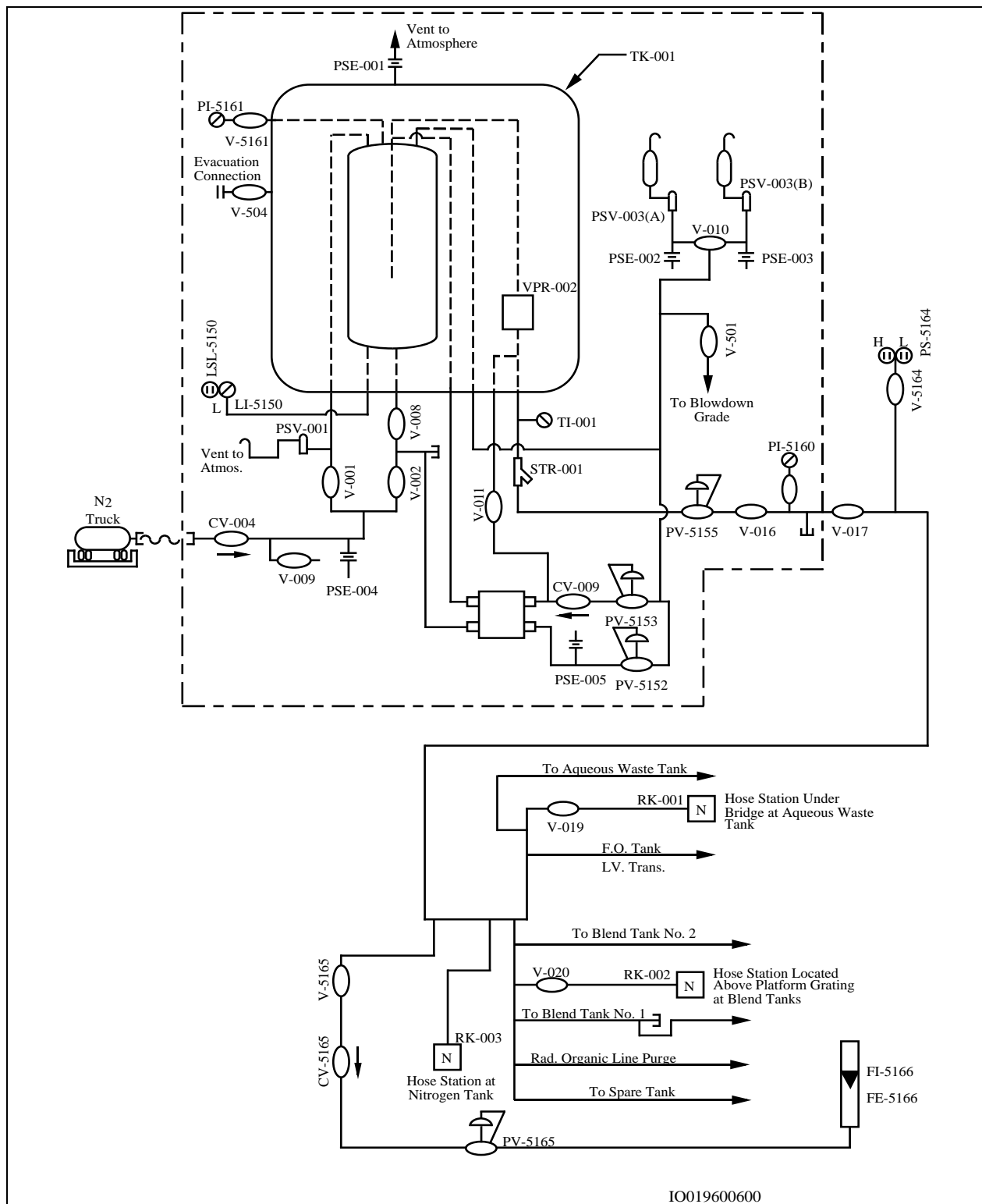


Figure 4 Nitrogen System

Liquid nitrogen is received from tanker trucks via a hose connection and stored in a 600-gallon vacuum jacketed, insulated tank which is located in the Tank Farm Area near the Clean Truck Unloading Pad. The pressure vessel is suspended inside a vacuum jacket and insulated with perlite powder. The liquid and gas phase lines to the pressure vessel pass through the lower head of the vacuum jacket. All piping is designed to withstand the stresses caused by expansion and contraction of the pressure vessel, its support system, and the piping itself.

Bottled nitrogen is also provided for the Nitrogen Snuffing System at the Solid Waste Ram Feeder in the Incinerator System. Six nitrogen bottles are supplied and are piped to a common connection at the ram and solid feed chamber for fire suppression.

Nitrogen System Flowpath

Liquid nitrogen is delivered to and stored in a tank in the Tank Farm. The storage tank and associated components and instruments are located on the raised concrete pad near the Clean Unloading Area. The outlet of storage tank is joined to the nitrogen supply main header at a flanged connection.

The main 1-1/2" supply header distributes gaseous nitrogen at 90 psig pressure to five (5) tanks and two (2) hose stations. It branches to a HIGH/LOW pressure switch which interfaces with the DCS alarm panel in the Control Room. The liquid nitrogen is fed through an ambient air vaporizer and delivered as a gas at 90 psig through 1-inch lines to the pressure reducing valves located at each of the four (4) waste tanks. These valves reduce the nitrogen pressure from 90 psig to 2" Water Column (inwc), and deliver nitrogen gas to the waste tanks through 1-inch lines. There are also hose connections for purging at the Nitrogen Tank, Aqueous Waste Tank, and The Blend Tanks.

During normal operation, the tank pressure forces liquid through a siphon withdrawal line and the vaporizer inlet valve to an ambient air vaporizer, which feeds the waste tank nitrogen inlet pipeline. To compensate for lowering of tank pressure as nitrogen is withdrawn, the pressure regulator allows a regulated amount of gas to flow to the top of the tank to provide the driving force for uninterrupted withdrawal.

During periods when the withdrawal rate is low and tank pressure rises above an economizer regulator's setpoint, the economizer circuit becomes operational. The liquid withdrawal is interrupted and gas flows through the economizer regulator and its check valve and isolation valve to the vaporizer, thereby supplying the pipeline with gas that would otherwise be vented to the atmosphere.

The pressure-reducing valves maintain pressure when flow of waste is out of the tank. Conversely, the tank vent relieves increasing blanket gas pressure to the tank farm stack as liquid waste is transferred into the waste tank.

Compressors and Air Dryers

E.O. 2.2	DESCRIBE the physical layout of the Air Systems components including, the
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general location, how many there are, and functional relationship for each of the following major components:

- a. Plant/Instrument Air Compressors and Dryers
- b. Breathing Air Compressor and Dryers

The Plant, Instrument and Breathing Air Systems are routed throughout the facility via distribution headers. The compressors are physically located on concrete pads east of the Box Handling Area of Building 261-H.

The three (3) compressors used to provide plant, instrument, and breathing air have two (2) flowpaths which will be discussed. The flowpaths include the air flow through the compressor and the oil flow used to cool components associated with the compressor. Two (2) compressors (PA-CMP-0001 and PA-CMP-0002) are provided for supplying the plant and instrument air and one (1) compressor (BA-CMP-0001) is provided for supplying the breathing air. Since these three (3) compressors are identical, the description given is the same for each. The instrument air dryer and the breathing air dryer are slightly different and will be discussed separately.

Also, each of the three (3) compressors and two (2) air dryers are provided with a separate alarm and control panel and locally mounted indicators to monitor and alert the operator of equipment failure within these five (5) major components.

Compressor Air Flowpath

Outside air enters the compressor through an intake silencer, next passing through an intake filter and then through the capacity control valve to the first-stage low pressure assembly. Exiting the low pressure assembly, the heated air passes through an air-cooled intercooler, through a moisture separator to the second-stage high pressure compressor assembly where the pressure and temperature of the air is further increased.

Next, the air exits the high pressure assembly and passes through a pulsation damper and silencer, an air-cooled aftercooler, and a second moisture separator. The air then exits the second moisture separator and is sent to an air receiving tank (RCVR-0001).

The plant air is sent to the facility for distribution and the instrument air is sent to the Instrument Air Dryer (IA-DRY-0001) for further processing. If the compressed air is for the Breathing Air System, the air is sent to the Breathing Air Dryer (BA-DRY-0001) for further processing.

Compressor Oil Flowpath

Each compressor is provided with an oil reservoir. Each reservoir is provided with a pressure control valve, an oil sump electric heater, a strainer, and an oil pump.

The oil is pumped from the reservoir to an oil cooler and through a temperature control valve. After the control valve, the oil passes through a filter prior to entering both the first-stage/low pressure and second-stage/high pressure compressor assemblies. Entering the bottom of the assemblies, the oil cools the components and exits out the top of the assemblies. From the assemblies, the oil is recirculated back to the oil reservoir.

Instrument Air Dryer Flowpath

Air exiting the receiver tank enters one of two (2) coalescing filters. These filters are arranged in parallel. A differential pressure measurement across the filters will determine when the filters should be switched. After the filters, the air enters one of two (2) drying towers arranged in parallel. The air flow is reversed through the drying towers during the regeneration process. The towers are equipped with an electrical heater. The filter and heater arrangement ensure that instrument air is thoroughly cleaned and dried prior to being used in the facility. After passing through the drying towers, the clean and dried instrument air passes through a second set of coalescing afterfilters before being sent to the facility.

Breathing Air Dryer Flowpath

Air exiting the second-stage moisture separator enters the desiccant air dryer. The arrangement is similar to the instrument air dryer except that instead of two (2) coalescing filters in parallel there is only one. A differential pressure indicator is provided to determine when the filter needs to be replaced. After passing through the filters, the air enters one of two drying towers arranged in parallel. Air leaving the drying towers passes through a catalyst chamber and a second coalescing filter prior to being sent to the facility. A Carbon Dioxide (CO₂) analyzer is provided on the discharge side of the second filter. A high Carbon Monoxide (CO) indicator is also provided on the outlet to provide an alarm indication in the control room and at each of the breathing air stations.

Summary

- The Plant Air System is provided to satisfy process air requirements to hose stations located throughout the facility.
- The Instrument Air System is provided to satisfy requirements for clean, dry air at a steady pressure for air-operated valves and other pneumatically operated instruments throughout the facility.
- The Breathing Air System is provided to supply filtered and regulated breathing air to self-contained breathing apparatuses for respiratory protection to protect employees working in areas that are potentially radioactive or chemically contaminated.
- The Nitrogen System is provided to supply gaseous nitrogen for inert blanketing of liquid contents in waste tanks, purging of certain lines, and as a backup supply for the Instrument Air System.
- The source of compressed air for the plant, instrument, and breathing air in the CIF are three (3) new rotary air-cooled screw-type compressors.
- Compressed air is supplied at 100 psig for plant air and instrument air, and at 120 psig for breathing air.
- The Plant Air System distributes process air to the Tank Farm, Offgas Area, Incineration System Ashout/Ashcrete Area, and the Box Handling Areas.
- Instrument Air is supplied to the Tank Farm Area, Offgas Area, Incinerator & Ashout Area, and Bldg. HVAC & HEPA Filters Area (Bldg. 262-H).
- Breathing Air is supplied to the following 16 areas including the Offgas and HEPA Filter Area - four (4) stations, the Ashcrete, RK Feed, SCC Burner and Box Handling Area - five (5) stations, and the Tank Farm Area - seven (7) stations.
- Nitrogen is provided in the Tank Farm for purging the four (4) liquid waste tanks, the ROW System, and lines or equipment at hose stations, providing an inert blanket in the four (4) liquid waste tanks, providing an inert gas for the Fuel Oil tank level transmitter, pressurizing thermosyphons on liquid waste pumps, and providing backup for the Instrument Air System.

MAJOR COMPONENTS

Plant and Instrument Air Compressors

E.O. 3.1	DESCRIBE the following major components of the Air and Nitrogen Systems including their functions, principles of operation, and basic construction: <ul style="list-style-type: none">a. Plant and Instrument Air Compressorsb. Breathing Air Compressorc. Air Dryersd. Breathing Air Receivere. Nitrogen Storage Tankf. Nitrogen Ambient Air Vaporizerg. Nitrogen Economizer
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The Plant and Instrument Air Compressor package contains two (2) identical compressors (CMP-0001 and CMP-0002), each separately mounted on a skid and jointly connected to the common air receiving tank RCVR-0001. Air requirements (total flow rate) are 400 scfm. Nominal discharge pressure for the operating compressor is 125 psig. Only one compressor (lead) operates at any given time with the other compressor used as a standby unit (lag).

The air compressor units are air-cooled, rotary screw-type, two-stage types designed to deliver oil-free air. The multi-staging of the compressors allows for economical design and operation. Pressure is raised from atmospheric to approximately 25 psig in the first (larger) stage. After cooling the air and draining any condensate or moisture, air is delivered to the second stage. The compressor second stage raises the pressure to the design rated pressure of 110 to 125 psig. Figure 5, *Plant and Instrument Air Compressors and Dryer*, shows the major components for the compressors and instrument air dryer. (Note: Unless otherwise stated, all components associated with the Plant Air and Instrument Air Compressors begin with the prefix H-261-PA. All components associated with the Instrument Air Dryer will begin with the prefix H-261-IA).

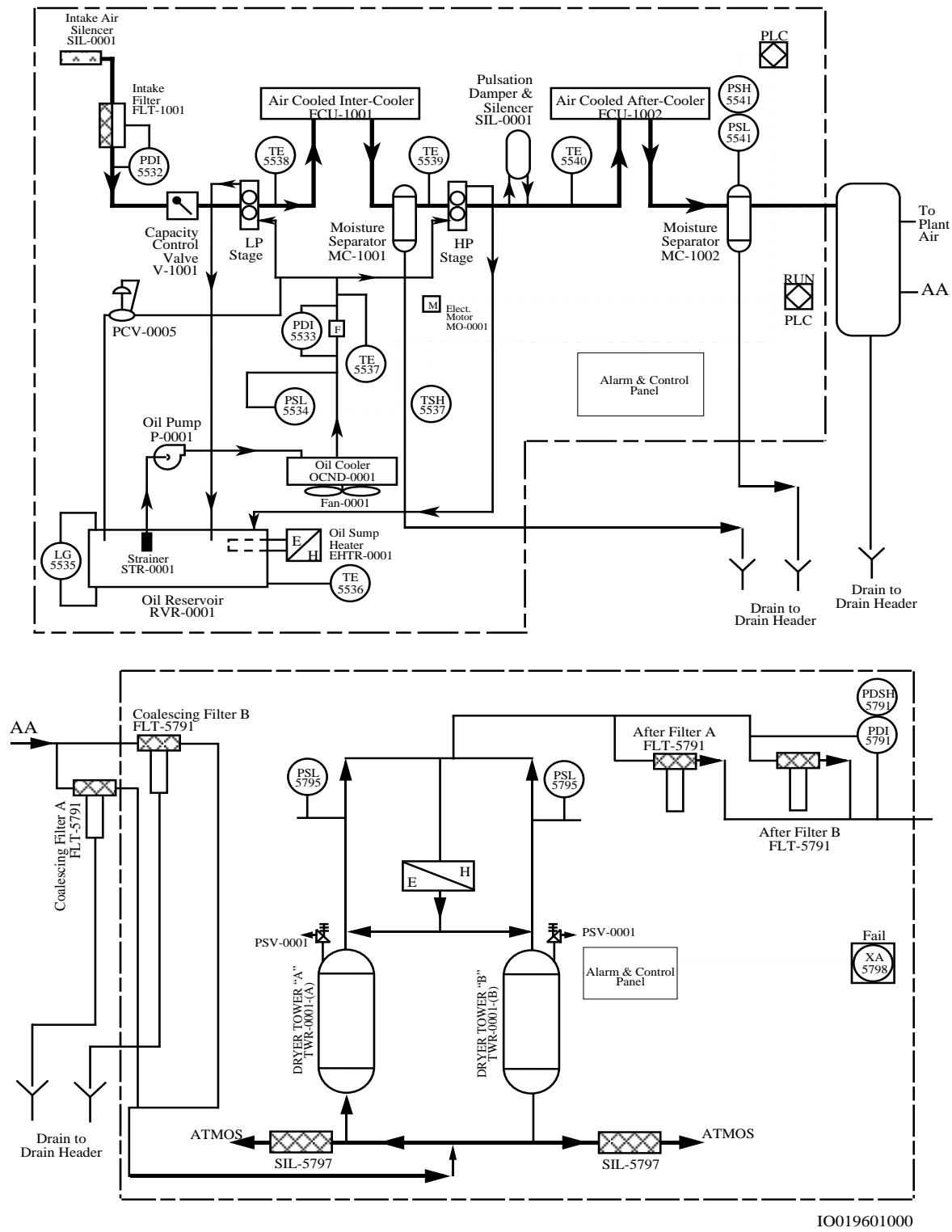


Figure 5 Plant and Instrument Air Compressors and Dryer

Each compressor package is self-contained and includes the following component features:

- Intake silencer, air intake filter, and capacity control valves
- First-stage/low-pressure compressor assembly with air-cooled intercooler
- Second-stage/high-pressure compressor assembly with air-cooled aftercooler
- Two moisture separators; one located after the first-stage air-cooled intercooler and one located after the air-cooled aftercooler
- Pulsation damper and air discharge silencer located after the first-stage moisture separator
- Lubricating oil reservoir, oil pump, oil filter, and piping
- Check valves located on the drain side of the first-stage moisture separator and after the pulsation damper
- Alarm and Control Panel; each panel is provided with alarms to monitor compressor operation and associated controls for compressor unloading or shutdown

The air compressor units are installed outdoors. To protect the unit from severe weather conditions, necessary freeze/low ambient temperature protection is provided on each unit.

NOTE	Plans are underway to build an enclosure for the compressors because of the severity of the ambient temperatures during the summer and the effect the heat has on compressor operations.
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The air compressors will not eject toxic gases, vapors, particulate or other forms of contamination into the air stream. Air quality shall be completely dependent on intake air quality.

Breathing Air Compressor

The Breathing Air Compressor (BA-CMP-0001), Figure 6, *Breathing Air Compressor and Dryer*, is an air-cooled, two-stage, rotary screw-type compressor designed to deliver oil-free air. The compressor is identical to the plant and instrument air compressors except that it is smaller in size and capacity. (Note: all components associated with the Breathing Air Compressor and Air Dryer will begin with the prefix-H-261-BA). The compressor delivers 240 scfm air at 120 psig design discharge pressure. The compressor assembly aftercooler is a shell and tube-type heat exchanger used to lower the outlet air temperature from the compressor (120°F maximum) to suitable temperature (approximately 15°F above ambient temperature) for use at the breathing air manifolds.

Air Dryers

Both breathing and instrument air must be dried before being distributed to various stations. The air dryers are designed to provide moisture-free, low dew point air for the facility.

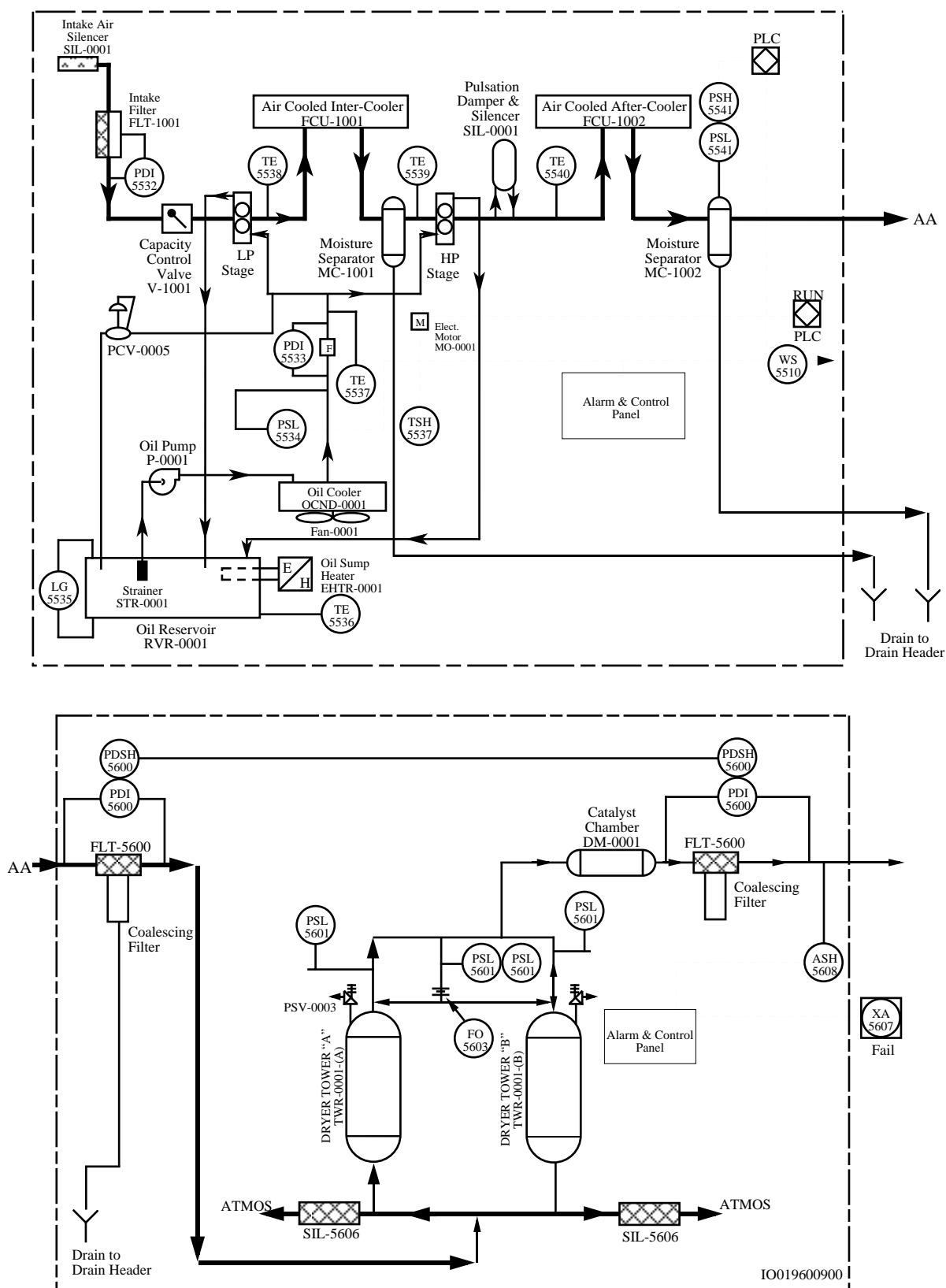


Figure 6 Breathing Air Compressor and Dryer

The units have dual drying towers, designed for a maximum pressure drop less than 5 psi at rated flow, temperature, and pressure. The units are provided with inlet prefilters/coalescing filters (Instrument Air Dryer has two arranged in parallel) with isolation valves for uninterrupted use of the dryer during filter maintenance. The prefilters are capable of coalescing 99.99% dispersed liquids and filtering 98% solids, 0.03 microns and larger. The dryers are also provided with particulate coalescing afterfilters (two in parallel are provided for the Instrument Air Dryer).

The afterfilters are designed for 100% retention of solids, 0.9 micron and larger. The initial clean element pressure drop across each filter should not exceed 0.4 psi at rated flow. The filter elements are glass fiber and removable. Filter vessels have drain connections with automatic discharge traps. Filters have tap-off connections for instrumentation and controls.

The Instrument Air Dryers are heat-reactivated desiccant air dryers that use electrical heating elements. The dryer units include prefilters, afterfilters, electrical heating elements for regeneration, desiccant, valves and piping, instrumentation and controls, blowdown ports, and mufflers. The maximum flow rate through the dryers is 80 scfm. Design operating pressure is 125 psig, design maximum temperature is 120°F, minimum temperature is -3°F, and required dew point temperature at line pressure is -20°F. Power supply for the dryers and controls is 120 VAC, one phase, 60 Hz.

The Breathing Air Dryer unit is the heatless regeneration type that does not use more than 25% of the rated capacity of air for regeneration purposes. The dryer includes an air purifier/catalyst. The maximum flow rate through the dryer is 240 scfm. Design operating pressure is 120 psig, design maximum temperature is 120°F, minimum temperature is -3°F and required dew point temperature at line pressure is -20°F. Power supply for the dryer and controls is 120 VAC, one phase, 60 Hz.

Regeneration flow through the dryers is in the reverse direction of normal flow to the system. This is done to mitigate the effects of channeling. Channeling is seen as the formation of a depression or channel in the desiccant bed. This occurs over time as the air flow follows the path of least resistance. An undesired effect of air dryer channeling is the premature exhaustion of desiccant which leads to uneconomical replacement of desiccant. By reversing the regeneration air flow, the desiccant bed is leveled and more efficiently utilized.

Breathing Air Receiver

The breathing air receiver is used to provide a stored supply of air (five (5) minutes for a maximum of six (6) users) in the event of loss of air supply. The receiver is a 9'-0" diameter by 3'-6" high (between seams) vertical pressure vessel constructed of stainless steel. The tank has a volume of 599 cubic feet (ft³), capacity of 660 gallons and is designed to operate at pressures up to 150 psig. Air is routed from the receiver to sixteen (16) stations throughout the CIF via 2" lines at a design flow rate of 30 scfm.

The receiver is also used to drain additional moisture from the stored air. To do this, the receiver is equipped with an automatic drain and bypass arrangement to expel condensed moisture from the bottom of the vessel. The vessel drains via a 3/4" line through a SARCO trap to the building trench, or through a separate 3/4" line to the floor.

A pressure relief valve (PSV-001) located in a line exiting the roof of the breathing air receiver, is set at 140 psig; the pressure inside the vessel will not exceed this value.

Nitrogen Storage Tank

Liquid nitrogen is received from a tanker truck via a hosed connection. The Nitrogen Tank Volume/Capacity is 600 gallons. The tank has a relief valve mounted on the shell set at 250 psig.

Nitrogen Ambient Air Vaporizer

Liquid nitrogen is fed from the storage tank to the vaporizer and is expanded at a maximum rate of 2,500 standard cubic feet per hour (SCFH) to form nitrogen gas for use in the tank farm.

Nitrogen Economizer

The nitrogen economizer is used to maintain tank pressure and prevent excess discharge of nitrogen gas to the atmosphere. (Note: the economizer is identified in Drawing W830330, *Nitrogen System*, as the Pressurization Vaporizer)

During normal withdrawal operations from the storage tank, the pressurizer allows a small flow of nitrogen back to the top of the tank to provide a driving force for nitrogen removal. When the withdrawal rate from the nitrogen tank is low, the tank pressure increases and rises above the economizer regulator's setpoint. When the regulator opens, the liquid nitrogen is directed to the pressurizing vaporizer and returned back to the pipeline rather than relieved as a gas to the atmosphere through the relief valves on the headers.

Summary

- The Plant and Instrument Air Compressor package contains two (2) identical compressors, each separately mounted on a skid and jointly connected to the common air receiving tank RCVR-0001.
- Air requirements (total flow rate) are 400 scfm. Nominal discharge pressure for the operating compressor is 125 psig.
- Only one compressor (lead) operates at any given time with the other compressor used as a standby unit (lag).
- The air compressor units are air-cooled, rotary screw-type, two-stage, designed to deliver oil-free air
- Breathing air compressor is identical to the plant and instrument air compressors except that it is smaller in size and capacity.
- The compressor delivers 240 scfm air at 120 psig design discharge pressure.
- The compressor assembly aftercooler lowers the outlet air temperature from the compressor (120°F maximum) to suitable temperature (approximately 15°F above ambient temperature) for use at the breathing air manifolds.
- The instrument air dryer unit is a heat-reactivated desiccant air dryer using electrical heating elements. The maximum flow rate through the dryer is 80 scfm. Design operating pressure is 125 psig, and design maximum temperature is 120°F
- The breathing air dryer unit is the heatless regeneration type and does not use more than 25% of the rated capacity of air for regeneration purposes. Design operating pressure is 120 psig, design maximum temperature is 120°F, minimum temperature is -3°F, and required dew point temperature at line pressure is -20°F
- The Nitrogen Tank has a volume/capacity of 600 gallons and receives liquid nitrogen from a tanker truck via hosed connection.
- The Ambient Air Vaporizer expands the liquid nitrogen to form nitrogen gas for use in the Tank Farm.
- The Nitrogen Economizer is used to maintain tank pressure and prevent excess discharge of nitrogen gas to the atmosphere.

INSTRUMENTATION

E.O. 3.2	DESCRIBE the following Air and Nitrogen Systems instrumentation including, indicator location (local or Control Room) sensing points and associated instrument controls. <ul style="list-style-type: none">a. Plant Air Systemb. Instrument Air Systemc. Breathing Air Systemd. Air Compressorse. Air Dryersf. Nitrogen System
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Plant Air Pressure Instrumentation

Pressure transmitter PT-5750, located on the discharge side of the air compressors, monitors system pressure and sends a signal to the DCS. On low air pressure, low pressure switch PSL-5750 generates a LOW pressure alarm indication on PAL-5750 at 75 psig. System pressure is displayed by the pressure indicator PI-5750 in the Control Room. Local pressure indication is also displayed by PI-5751. Like transmitter PT-5750, the local pressure indicator is located on the discharge side of the air compressors.

Instrument Air Pressure Instrumentation

Pressure transmitter PT-5800, located on the discharge side of the instrument air dryers, monitors system pressure and sends a signal to the DCS. System pressure is displayed by pressure indicator PI-5800 in the Control Room. Low pressure switch PSL-5800 generates a LOW pressure alarm indication on PAL-5800 at 75 psig. Local pressure indication is also displayed by PI-5801. Like transmitter PT-5800, the local pressure indicator is located on the discharge side of the instrument air dryers.

Breathing Air Instrumentation

Breathing air temperature and pressure alarms, along with breathing air compressor or air dryer failure alarms, are all associated with interlocks to the PLC. The interlocks activate all visual and audible alarms associated with breathing air stations. The temperature and pressure alarms are displayed in the Control Room.

Figure 7, *Breathing Station and Local Alarm Panel*, shows the relative location of each of the sensing instruments discussed in this section.

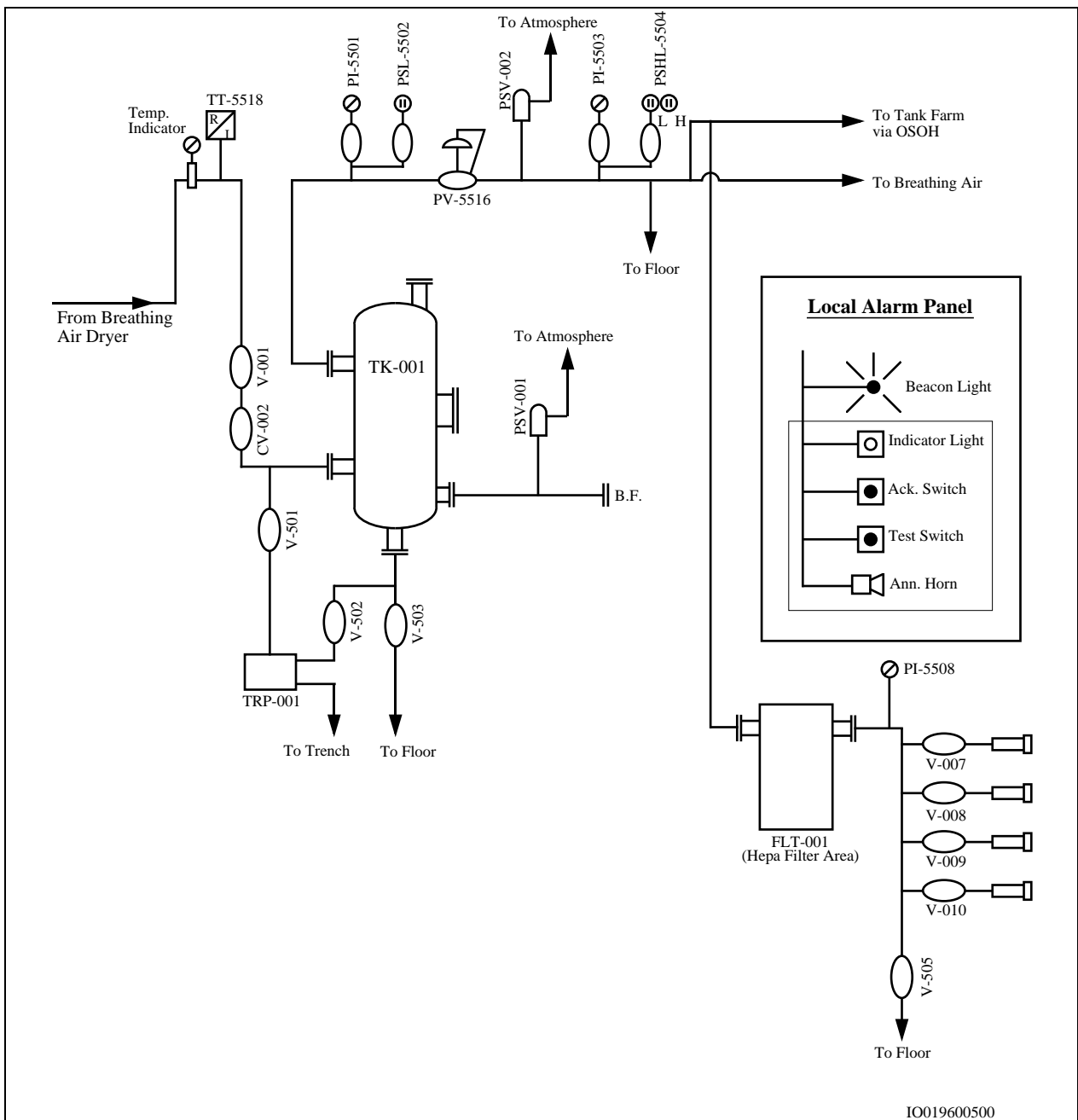


Figure 7 Breathing Station and Local Alarm Panel

Breathing Air Temperature

Temperature transmitter TT-5518, located on the discharge side of the breathing air dryer, monitors system temperature, converts a change in resistance to a proportional current signal, and sends this signal to the DCS. System temperature is displayed on temperature indicator TI-5518 in the Control Room. A temperature indicator TI-5517, located in the same area as the transmitter, provides local indication of the same temperature.

The signal from transmitter TT-5518 is also sent to two (2) temperature switches located on the DCS in the Control Room. The low temperature switch TSL-5518 will generate a LOW temperature alarm on the DCS and on panel H-261-HM-PNL-2405-B in the Control Room. The high temperature switch TSH-5518 will generate a HIGH temperature alarm on the DCS and on H-261-HM-PNL-2405-B panel in the Control Room. Refer to Table 3, *Breathing Air Instrument Alarms*, for temperature alarm information including setpoint and location.

Breathing Air Pressure

Breathing air leaving the receiving tank passes through pressure reducing valve PV-5516. This valve will maintain the pressure at 120 psig. A pressure indicator (PI-5501) and a LOW pressure switch (PSL-5502), located on the discharge side of the receiving tank prior to PV-5516, and pressure indicator PI-5503 and a HIGH/LOW pressure switch (PSHL-5504), located on the discharge side of PV-5516, monitor the breathing air pressure. Also provided on the discharge side of PV-5516 is a pressure relief valve (PSV-002) which is set at 135 psig and will discharge to the atmosphere when its setting is reached.

The LOW pressure switch PSL-5502 will generate a LOW pressure alarm on the DCS and on panel H-261-HM-PNL-2405-B in the Control Room. The HIGH/LOW pressure switch PSHL-5504 will generate a HIGH pressure alarm on the DCS and on panel H-261-HM-PNL-2405-B in the Control Room. The HIGH/LOW pressure switch PSHL-5504 will also generate a LOW pressure alarm on the DCS and panel H-261-HM-PNL-2405-B in the Control Room. Refer to Table 3, *Breathing Air Instrument Alarms*, for pressure alarm information including setpoint and location.

When Breathing Air Compressor CMP-0001 fails, relay WS-5510, located inside the compressor, sends a signal to ANN-5510-A on the DCS and on panel H-261-HM-PNL-2405-B in the Control Room. WS-5510 will annunciate these alarms because of abnormal temperature or pressure readings in the compressor or air dryer, component failure within the compressor or air dryer, or carbon dioxide readings from ASH-5608 located on the discharge side of the afterfilter in the air dryer. Refer to Table 3, *Breathing Air Instrument Alarms*, for failure alarm information including setpoint and location.

Table 3, *Breathing Air Instrument Alarms*, provides a complete list of Breathing Air alarms including identification number, setpoint, and location.

Table 3 Breathing Air Instrument Alarms

ALARM NUMBER	SETPOINT	LOCATION
TAL-5518-A	50 °F	Breathing Air LOW Temp on DCS
TAL-5518-B	50 °F	Breathing Air LOW Temp on PNL-2405-B
TAH-5518	90 °F	Breathing Air HIGH Temp on DCS
TAH-5518-B	90 °F	Breathing Air HIGH Temp on PNL-2405-B
PAL-5502-A	95 psig	Breathing Air LOW Press on DCS
PAL-5502-B	95 psig	Breathing Air LOW Press on PNL-2405-B
PAH-5504-A	125 psig	Breathing Air HIGH Press on DCS
PAH-5504-B	125 psig	Breathing Air HIGH Press on PNL-2405-B
PAL-5504-A	95 psig	Breathing Air LOW Press on DCS
PAL-5504-B	95 psig	Breathing Air LOW Press on PNL-2405-B
ANN-5510-A	Failure	Compressor Failure on DCS
ANN-5510-B	Failure	Compressor Failure on PNL-2405-B

Any of these measuring parameters which actuate breathing air alarms or the compressor failure alarm will also actuate a beacon warning light and warning horn on the alarm panel at each of the 16 remote breathing air stations. These alarms notify the Breathing Air System users to evacuate the area due to system failure.

Figure 7, *Breathing Station and Local Alarm Panel*, provides a representative sample of each of the 16 breathing air alarm panels and stations. As shown in Figure 6, each of the breathing air stations consists of a filter housing and cartridge, a manifold, and four (4) connections. Each of the connections will deliver 30 cubic ft/min. through 150 feet of 3/8" breathing hose to a plastic breathing suit. The maximum permitted load of the system is six (6) users at any one time.

Table 4, *Breathing Air Station and Local Panels*, identifies the station location, filter housing number, local panel number, and pressure indicator. The beacon light (QI-A), indicator light (QI-B), and annunciator horn (ANN) have the same identifying number as the panel. For example, the HEPA filter area beacon light would be QI-5507-A, the indicator light would be QI-5507-B, and the annunciator horn would be ANN-5507.

Table 4 Breathing Air Stations and Local Panels

STATION	FILTER HOUSING	LOCAL PANEL	PRESSURE INDICATOR
HEPA Filter Area	FLT-001	PNL-5507	PI-5508
Offgas Area, Upper	FLT-002	PNL-5514	PI-5515
Offgas Area, Lower	FLT-003	PNL-5512	PI-5513
Offgas Area, Lower	FLT-004	PNL-5520	PI-5519
Ashcrete Area	FLT-005	PNL-5650	PI-5651
SCC Burner Enclosure	FLT-006	PNL-5658	PI-5659
RK Feed Area	FLT-007	PNL-5652	PI-5653
Box Handling Area	FLT-008	PNL-5654	PI-5655
Box Handling Area	FLT-009	PNL-5656	PI-5657
Tank Farm, Lower	FLT-010	PNL-7300	PI-7301
Tank Farm, Upper	FLT-011	PNL-7304	PI-7305
(Regulated) Truck Unloading Platform	FLT-012	PNL-7302	PI-7303
Tank Farm, Lower	FLT-013	PNL-7308	PI-7309
Tank Farm, Upper	FLT-014	PNL-7306	PI-7307
Tank Farm, Upper	FLT-015	PNL-7312	PI-7313
Tank Farm, Lower	FLT-016	PNL-7310	PI-7311

Compressor Instrumentation

Each of the three (3) compressors is identical in design and is provided with instrumentation to monitor the air and oil flowpaths within the compressor. This instrumentation includes the following:

- Intake filter D/P indication
- Temperature indication between LP stage and intercooler
- Temperature indication between first moisture separator and HP stage
- Temperature indication between pulsation damper and after cooler
- Pressure indication at the second moisture separator
- Pressure relief valve after the second moisture separator
- Pressure differential of the oil filter
- Temperature indication of the oil reservoir
- Temperature indication of the oil after the filter

Each of the compressors is provided with its own alarm and control panel. Table 5, *Compressors Alarm and Control Panels*, provides the alarm number, setpoint, and location for the compressors.

Table 5 Compressors Alarm and Control Panels

PA/IA Comp-0001 Alarms	PA/IA Comp-0002 Alarms	BA Comp-0001 Alarms	Setpoint	Description/Location
TAH-5754	TAH-5774	TAH-5536	60 °F	Oil Reservoir temperature HIGH
TAH-5757	TAH-5777	TAH-5537	150 °F	Oil temperature HIGH after filter
TAH-5758	TAH-5778	TAH-5538	410 °F	HIGH air Temperature after LP stage
TAH-5759	TAH-5779	TAH-5539	455 °F	HIGH air Temp after moisture separator
TAH-5760	TAH-5780	TAH-5540	150 °F	HIGH Temp after pulsation damper
PAL-5756	PAL-5776	PSAL-5534	20 psig	LOW Oil pressure after oil cooler

XA-5765	XA-5784	XA-5542		Compressor failure
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Air Dryer Instrumentation

Instrumentation on the air dryers includes pressure gauges for the dryer unit inlet and outlet, pressure gauges for the desiccant towers, high differential pressure alarms for the filter units and additional dryer contacts for remote indication, purge flow indication, power on/off, tower drying indicating lights, tower switching failure alarm, and purge exhaust valves open/close indication. The breathing air dryer unit is also provided with a Carbon Monoxide (CO) Monitor ASH-5608 and alarm. Each of the dryers is also provided with its own Alarm and Control Panel. The Breathing Air Dryer BA-DRY-0001 panel contains the following alarms:

- MAH-5604 - HIGH Moisture Alarm
- AAH-5608 - HIGH CO Discharge Air Alarm
- PDAH-5600 - HIGH D/P Alarm across filters
- XA-5609 - Dryer Failure Alarm

The Instrument Air Dryer IA-DRY-0001 contains the following alarms:

- MAH-5792 - HIGH Moisture Alarm
- TAH-5794 - HIGH Dryer Temperature Alarm
- XA-5799 - Dryer Failure Alarm

Breathing Air Carbon Monoxide (CO) Monitor

The Breathing Air System is equipped with a CO monitor ASH-5608, located on the discharge side of the dryer prior to the receiving tank, designed to continuously monitor the level of CO in the Breathing Air System. The monitor has a display that provides a digital readout in parts per million (ppm), audible and visual alarms that sound when the preset threshold limits are reached, a filter and controller for the sensor and associated controls, relays and circuits.

Air enters the monitor through the filter and a flow controller and then passes on to the sensor cell. There is an indicator on the front of the panel to show the air flow through the filter. The sensor is an electrochemical-type sensor that determines the amount of CO present and will send a proportional signal to the display through an integrated circuit.

Nitrogen System Instrumentation

Pressure is monitored on the discharge header by a HIGH/LOW pressure switch PS-5164. This pressure switch monitors head pressure and generates a HIGH pressure alarm PAH-5164 at 100 psig, or a LOW pressure alarm PAL-5164 at 70 psig on the DCS in the Control Room. Local storage tank pressure is also indicated on PI-5161.

On the tanks, nitrogen flows through pressure regulating valves and enters the tanks from the top of a 1" tee. Pressure regulating valves are preset at 2 inwc. As tank pressure fluctuates, the pressure regulating valves will cycle as required to maintain 2 inwc.

The nitrogen tank and associated piping upstream of the pressure reducing valves are protected from over pressurization by a series of relief valves, each with setpoints of approximately 250 psig. The piping downstream of the pressure reducing valves is protected by two relief valves, each with a setpoint of approximately 90 psig. Local pressure indicators are also mounted by the relief valve vent lines to the atmosphere.

Pressure differential indicators and bubbler-type gauges are used to indicate tank level on the nitrogen storage tank and tank farm tanks. Level switch LSL-5150 on the nitrogen storage tank will transmit a corresponding signal to the DCS to indicate a LOW level of 25" in the tank.

A flow switch (FSH-5166), located on the discharge side of pressure reducing valve PV-5165 monitors the flow of nitrogen to the Instrument Air System in the Tank Farm. The switch will provide a HIGH flow alarm FAH-5166 on the DCS.

Summary

- Plant air pressure is monitored and provides a LOW alarm indication on the DCS at 75 psig.
- Instrument air pressure is monitored and provides a LOW alarm indication at 75 psig.
- Breathing air temperature on the discharge side of the dryer is monitored and provides a LOW alarm at 50°F and a HIGH alarm at 90°F on the DCS.
- Breathing air pressure is monitored on both sides of the pressure reducing valve PV-5516. Alarm indications are provided on the DCS. Pressure is monitored and controlled between 90-125 psig.
- Each of the 16 breathing air stations is provided with an Alarm Control Panel.
- Instrumentation is provided to monitor and control the air and oil flowpaths through each compressor. Temperature or pressure indications that exceed setpoint limits will alarm on the control panel provided on each compressor.
- Breathing air dryer alarms include HIGH moisture, HIGH CO in the discharge line, HIGH D/P across the filters, and dryer failure.
- Instrument air dryer alarms include HIGH moisture, HIGH temperature, and dryer failure. D/P indication across the filters is also given.
- Nitrogen pressure on the discharge header is monitored and provides a LOW pressure alarm at 70 psig and a HIGH pressure alarm at 100 psig on the DCS.

CONTROLS, INTERLOCKS AND ALARMS

Controls

E.O. 3.3	EXPLAIN how the following Air and Nitrogen Systems equipment are controlled in all operating modes or conditions to include: control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on component operation. <ul style="list-style-type: none">a. Air Compressorsb. Air Dryersc. Nitrogen System
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Control of the air systems is limited to control of individual components rather than complete system control. The control of components requiring instrument or plant air is performed by the DCS or manually by actuation devices in the specific systems requiring air support. Breathing air headers are pressurized and available for the immediate needs of individual workers.

The control basis of the Nitrogen System involves both the control of components and system operations. Nitrogen pressure in the storage tanks is regulated by pressure regulating valves at each tank. Nitrogen flow is based on the need to makeup the nitrogen blanket pressures. System monitoring is performed on the DCS, but manual operation can be performed at any time. The DCS automatically receives alarm inputs and annunciates the indication to the operator. Operator intervention during critical events is allowed and manual control of important parameters can be initiated. System and component status is provided in real time on the DCS.

Plant and Instrument Air Compressors

The compressor package is equipped with safety interlocks and an electronic processor/controller to automatically shut down the compressor in the event of trouble/failure in any of the vital operating systems. The compressor is equipped with automatic start/stop controls with additional terminal points for use in remote operation, including override function for remote operation. The compressor has an auto-start feature for use after a power outage.

Air Compressors #1 and #2 are equipped with lead/lag operation as indicated on Compressor #1 display panel. Air Compressor #1 and Air Compressor #2 have two pressure switches set at 125-110 psig in LEAD mode and 120-105 psig in LAG mode. The mode of operation is determined by placing the LEAD/LAG switch on Air Compressor #1 to the desired mode of operation, and Air Compressor #2 will assume the non-selected mode of operation. This ensures that only one compressor is selected to the LEAD mode at any one time.

Each air compressor package is furnished with an individual programmable controller which indicates total hours run-idle time, trouble code or direct display of the trouble, and controls automatic stopping of the compressor after preset run time. The controllers included in the Plant and Instrument Air Compressors interface such that sequential operation between the two compressors (lead and lag) can be programmed.

Air Dryers

Dryers are equipped with a CO Monitor and alarm for the breathing air dryer unit and additional contact/relay for remote indication with an associated automatic shutoff of the compressor. The dryers have automatic restarts after a power outage. The dryers also have a moisture controller and monitor, alarms, and automatic tower switchover capability. The automatic switchover capability allows for a four hour regeneration of the idle tower and then a four hour cool down period. At the completion of the eight hours, the on-line tower is isolated from normal flow by operation of solenoids and the idle tower is placed in service.

Nitrogen Flow Control to Rad Organic Waste (ROW) Feed Pumps

A 1" line supplies nitrogen to the ROW Feed Pumps purge of the circulating system between DWPF and the CIF. Nitrogen flows through 1" isolation valve V-030 to 1/2" strainer STR-002 and the pressure regulating valve PV-0626. The line branches to the pressure indicator PI-0627 first and then through locked open (L.O.) isolation valve V-0628-A to air-operated flow control valve FV-0628. The flow control valve is operated by three-way solenoid valve FY-0628 with two positioning switches: ZS-0628-A for valve opening and ZS-0628-B for closing. The switches may be manually operated by dual pushbutton HS-0628 which, together with the valve position indicators ZI-628-A and ZI-0628-B, are located in the Control Room.

Interlocks

E.O. 3.4	DESCRIBE the interlocks associated with the Air and Nitrogen Systems equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary. <ol style="list-style-type: none">Instrument Air SystemAir CompressorsNitrogen System
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Plant and Instrument Air System components alarm on the DCS when parameters are exceeded. Breathing Air System components are interlocked with different functions and parameters in the CIF. There are also parameters in the Breathing Air System identified in Table 3, *Breathing Air Instruments and Alarms*, that initiate interlocks and alarm conditions on the DCS.

Instrument Air System

An interlock with the Programmable Logic Controller (PLC) is provided to shut down the Incineration System by initiating a Burner Management System (BMS) shutdown signal on a low Instrument Air pressure of 75 psig. This is provided to ensure that enough Instrument Air pressure is available to operate the pneumatic controls associated with the fuel and waste feeds, combustion air, and safety devices and controllers associated with the incinerator.

Air Compressors

The compressors have safety interlocks to stop in the event of abnormal indications or compressor failure. This failure can occur due to HIGH temperature alarms in the air flowpath or LOW oil pressure in the oil flowpath. Also, in the case of the Breathing Air Dryer, a safety interlock will stop the compressor on a high CO condition as indicated by the CO monitor ASH-5608. Interlock actuation could result in system shutdown and/or alarms.

Nitrogen System

Interlocks are provided to shut down the incinerator in the event of a loss of nitrogen pressure for the inert blankets on the liquid waste tanks in the Tank Farm. This is done to mitigate the effects of exothermic reactions in the stored liquid wastes.

Limits

- E.O. 3.5** **STATE** the limits for the following Air and Nitrogen Systems and major components:
- Plant and Instrument Air Compressors
 - Breathing Air Compressor
 - Air Dryers
 - Breathing Air Receiver
 - Nitrogen System

Plant and Instrument Air Components

- Maximum allowable discharge pressure: 135 psig
- Maximum air temperature leaving compressor: 120°F

Air Compressor Limits

Limits for the Plant, Instrument and Breathing Air Systems and their respective compressors are displayed in Table 6, *Air Compressor Limits*.

Table 6 Air Compressor Limits

Alarms	Setpoint	Description/Location
PAL-5750	75 psig	Plant Air Pressure LOW
PAL-5800	75 psig	Instrument Air Pressure LOW
TAL-5518	50 °F	Breathing Air Temperature LOW
TAH-5518	90 °F	Breathing Air Temperature HIGH
PAL-5502	95 psig	Breathing Air Pressure LOW
PAH-5504	125 psig	Breathing Air Pressure HIGH
PAL-5504	95 psig	Breathing Air Pressure LOW
ANN-5510	Failure	Breathing Air Compressor Failure

Breathing Air Receiver

- Operating temperature: -20°F to 200°F
- Pressure relief valve set: 150 psig

Instrument Air Dryers

- Flow (max.): 80 scfm
- Temperature (max.): 120°F
- Temperature (min.): -3°F
- Required dew point temperature at line pressure: -21°F
- Maximum pressure drop across each filter will exceed 5 psig at rated flow
- The initial (clean element) pressure drop across each filter will not exceed 0.4 psig

Breathing Air Dryers

- Flow (max.): 240 scfm
- Pressure: 120 psig
- Maximum air temperature leaving aftercooler: 15°F above ambient (<120°F)
- Temperature (min.): -3°F
- Required dew point temperature at line pressure: -20°F
- Maximum pressure drop across each filter will not exceed 5 psig at rated, temperature, and pressure
- The initial (clean element) pressure drop across each filter will not exceed .04 psig

Nitrogen System

- Storage Tank relief valve: 250 psig
- Downstream piping relief valves set: 90 psig
- LOW level tank alarm setting: 25"

Summary

- Only one compressor (lead) operates at any given time with the other compressor used as a standby unit (lag). If the lead compressor shuts down, the lag compressor is started.
- Each air compressor package shall be furnished with an individual PLC.
- The controllers included in the Plant and Instrument Air Compressors shall interface such that sequential operation between the two compressors (lead and lag) can be programmed.
- There are no interlocks associated with the Plant and Instrument Air Systems.
- Compressor safety interlocks used to stop the compressor include HIGH temperature alarms in the air flowpath, LOW oil pressure in the oil flowpath, or compressor failure.
- Breathing Air Compressor is interlocked to shut down on CO indication in the supply line.
- Interlocks shut down the incinerator or the Offgas System during loss of nitrogen pressure.

SYSTEM INTERRELATIONS

Plant Air System

The Plant Air System interfaces with the following systems by providing air for operation of pneumatic equipment, instruments and controls:

- Tank Farm (Waste Tanks, Truck Unloading, hose stations)
- Offgas Area (Quench Vessel Spray Nozzle, Filtrate Backwash Tank, Filter Pumps, Condensate Pump, hose stations)
- Incinerator Area (Rotary Kiln (RK) Air Cylinder, hose stations)
- Ashcrete Area (Drum Spray Diaphragm Pump, hose stations)
- Box Handling Area

Instrument Air System

The Instrument Air System interfaces with the following systems by providing air for the operation of valves and instruments:

- Tank Farm
- Offgas
- Incinerator
- HVAC
- Ashcrete
- Fire Protection

Breathing Air System

The Breathing Air System supplies the following 16 breathing air stations (number of stations are in parentheses):

- Rotary Kiln Feed Area
- Secondary Combustion Chamber (SCC) Louver Enclosure
- Box Handling Area (2)
- Tank Farm (7)
- Offgas Lower Area (2)
- Offgas Upper Area
- HEPA Filter Area
- Ashcrete Area

Nitrogen System

The Nitrogen System interfaces with the Tank Farm by providing purge gas for waste tanks and the ROW line, inert nitrogen blankets in the tanks for the prevention of combustion, and for level and D/P instrumentation on the tanks. The bottled nitrogen for the nitrogen snuffing interfaces with the Solid Waste Feed System by providing a supply of inert gas for fire suppression in the ram feeder.

Summary

- Plant Air interfaces with the Tank Farm, Offgas, Incinerator, Ashcrete, and Box Handling Areas.
- Instrument Air interfaces with the Tank Farm, Offgas, Incinerator, HVAC, Ashcrete Areas, and the Fire Protection Dry Pipe System.
- Breathing Air is provided to 16 breathing air stations. These stations include one (1) each in the RK Feed Area, SCC Enclosure Area, HEPA Filter Area, and Ashcrete Area, two (2) in the Box Handling Area, three (3) in the Offgas Area, and seven (7) in the Tank Farm Area.
- Nitrogen System interfaces with the waste tanks in the Tank Farm, the Instrument Air System, and the Solid Waste Feed System.

INTEGRATED PLANT OPERATIONS

Normal Operations

E.O. 4.1	Given applicable procedures and plant conditions, DETERMINE the actions necessary to perform the following Air and Nitrogen Systems operations: <ol style="list-style-type: none">Mode 1 OperationsMode 2 OperationsMode 3 Operations
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Plant, Instrument, and Breathing Air Systems

Mode 1 Operations

During Mode 1 Operation, the compressed air systems distribute compressed air throughout the CIF as follows:

Plant Air is supplied to the Tank Farm, Offgas, Incinerator, Ashcrete, and Box Handling Areas. Instrument Air is supplied to the Tank Farm, Offgas, Incinerator, HVAC, Ashcrete Areas, and the Fire Protection Dry Pipe System.

Breathing Air is routed from the receiving tank to sixteen (16) stations throughout the CIF. Pressures and temperatures from the receiving tank are monitored at various locations, and alarm conditions are provided on the DCS and on panel H-261-HM-PNL-2405-B in the Control Room. The Breathing Air System must remain operational, and shutdown of the system would result in shutdown of the facility systems. All personnel engaged in maintenance activities or plant operations requiring the use of breathing air must enter the following information on Attachment 4 , *Breathing Air Log*, in procedure 261-SOP-BA-01, *Breathing Air (U)*, prior to performing activities:

- Name
- Social Security Number (SSN)
- Area & Authorization For Work
- Date
- Time In/Time Out

The Control Room Operator must authorize performance and use of breathing air by initialing the attachment.

Mode 2 Warm Standby and Mode 3 Cold Standby

During Mode 2 and 3 Operations, systems' pressures and temperatures are monitored as in Mode 1. Facility demand from Instrument and Plant Air Systems is reduced or not required. One requirement that would remain in Mode 2 would be to provide the RK and SCC cameras with cooling air until the incinerator has cooled to 250°F. In Mode 3 both systems (IA & PA) may be shut down for maintenance or portions of the systems isolated for specific activities. The Breathing Air System must remain operational during normal operation and also during Modes 2 and 3.

Nitrogen System

The operation of the Nitrogen System is important to reduce potential for accidental combustion of tanks contents.

Mode 1 Operations

During Mode 1 Operations, the Nitrogen System distributes gaseous nitrogen throughout the Tank Farm to four (4) liquid waste tanks and the Fuel Oil tank.

The liquid nitrogen is stored in a vacuum-jacketed insulated tank under 250 psig of pressure. The tank pressure is maintained by use of the system economizer which includes an ambient temperature vaporizer and pressure reducing valves.

During normal operation, liquid nitrogen enters the ambient temperature vaporizer through a 1" line and, in a gaseous form, flows through a thermowell valve and a pressure reducer to a 90 psig self-contained valve. From there it enters the 1-1/2" line leading to the previously mentioned tanks. The line has a LOW/HIGH pressure switch which is interfaced with high and low pressure alarms in the Control Room.

Mode 2-Warm Standby and Mode 3-Cold Standby

The Nitrogen System must remain operational in both of these modes in order to avoid accidental combustion of the tank's contents. Interlocks are in place to shut down the RK, the SCC, or the Offgas System.

Abnormal Operations

E.O. 4.2	Given a description of abnormal equipment status for Air and Nitrogen Systems, EXPLAIN the significance of the condition on system operation.
E.O. 4.3	Given a description of the Air and Nitrogen Systems equipment status, STATE any corrective actions required to return system operation to a normal condition.
E.O. 4.4	DETERMINE the effects on the Air and Nitrogen Systems and the integrated plant response when given any of the following: a. Indications/alarms b. Malfunctions/failure of components

Loss of Plant Air and Instrument Air

Loss of Plant Air and Instrument Air would impact normal facility operation and instrumentation. Pneumatically operated valves and dampers are required to fail in a safe position to mitigate the consequences of instrument air loss. Alarms or abnormal conditions associated with Plant Air and Instrument Air include: LOW Plant Air Pressure, Compressor #1 FAILURE, Compressor #2 FAILURE, Instrument Air Dryer FAILURE, and LOW Instrument Air Pressure.

The actions which an operator takes at the DCS console upon the actuation of any of the above-listed alarms is determined by the approved Abnormal Operating Procedure 261-AOP-PA-01, *Plant Air Events (U)*. An interlock with the PLC is also provided to shut down the Incineration System on low instrument air pressure.

In a loss of instrument air pressure situation, the following are possible causes the operator shall to inspect:

- Leaks - Observe all fittings, flanges, seals, and piping for evidence of leaks; leaks will cause loud whistling or squealing sounds.
- Compressor failure - Inspect compressor operation for proper discharge pressure, ramping or cycling, valve alignment.
- System valve alignment - Inspect piping, headers and lines for valve position, leaking or lifting safety and/or relief valves, or pneumatic valve operation.

Loss of Breathing Air

On a loss of Breathing Air pressure, workers in the area using breathing air may not be able to hear alarms or see the flashing beacons on the local alarm panels. Any operator in the vicinity needs to ensure the workers are made aware of the low pressure, notify the control room, and have workers remove the breathing air apparatus. Control room personnel should review the Breathing Air Log to ensure all personnel using breathing air are notified of the condition.

Loss of Nitrogen

Abnormal conditions associated with the Nitrogen System include component failure of the Nitrogen Tank Storage and Transfer System, Nitrogen Bottle Storage and Transfer System, Waste Tank Blanket Cover Gas Systems, or Nitrogen Snuffing Systems. Alarms include the following:

- LOW/HIGH Nitrogen Tank Pressure
- LOW Nitrogen Tank Level
- LOW, HIGH, or HIGH-HIGH Tank Pressure of the Aqueous Tank, Blend Tank 1 and 2, and Spare Tank Nitrogen Pressure Alarms
- LOW Nitrogen Snuffing Pressure and LOW Nitrogen Supply Pressure

The actions which an operator takes at the DCS console upon the actuation of any of the above-listed alarms is determined by the approved Abnormal Operating Procedure 261-AOP-NS-01, *Nitrogen Events (U)*.

Consequences associated with a loss of the Nitrogen System include the following:

- Nitrogen Blanketing System - liquid waste tank shutdown
- Tank Vent System - waste tank shutdown, toxic or radioactive release
- Loss of Instrumentation - excessive release, waste tank shutdown, loss of nitrogen blanket
- Nitrogen Tank Low or High Pressure Alarm - loss of nitrogen
- Loss of Main Nitrogen - liquid waste tank shutdown or Tank Farm shutdown

Low Nitrogen Fire Suppression Pressure

Nitrogen pressure in the six (6) bottles may drop to the alarm setpoint of 5 psig as indicated by DCS alarm H-261-FP-PAL-2105. In the event of a low pressure condition, the operators will be required to valve out the on-line bottle and valve in an unused bottle. The operator should first verify pressure indications on the local pressure gauge for the in-service bottle. If the pressure is low, then the operator should close the tank regulator outlet valve.

When the regulator outlet valve is closed, the local pressure gauge should decrease and approach 0 psig. Then, the operator should verify that the tank to be placed in service is, in fact, unused by inspecting the seal on the unused tank and ensuring it has not been broken. A broken seal could be an indication that the bottle has been previously used or expended. If the seal on the bottle to be placed in service is not broken, the operator should slowly open the regulator outlet valve and ensure that the local pressure gauge begins to show an increase in nitrogen pressure.

When the regulator outlet valve is fully opened, the operator should ensure that pressure indication is normal and steady. The operator will then identify the used bottle is expended or empty by placing a tag or DNO tag on the regulator outlet valve. The final step required is to notify maintenance that there is an empty bottle that requires replacing.

Emergency Shutdown

The Breathing Air System must remain operational during emergency shutdown, as well as during normal Incineration System operation. Abnormal conditions associated with the Breathing Air System include component failure of the compressor, dryer, header and header isolation valves, local breathing station regulator or filter cartridge, and plugged or cut hoses. Alarms include the following:

- Breathing Air Compressor FAILURE or Breathing Air Dryer FAILURE
- Air Compressor Pneumatic FAILURE
- LOW Plant Air Pressure
- High/LOW Breathing Air Temperature
- LOW Breathing Air Pressure Supply
- HIGH/LOW Breathing Air Pressure

The actions which an operator takes at the DCS console upon the actuation of any of the above-listed alarms is determined by the approved Abnormal Operating Procedure 261-AOP-BA-01, *Breathing Air Events (U)*.

Low Air Pressure

Pneumatic components have an airlock position that they adjust to or remain in when there is insufficient air pressure for continued operation. The position places the pneumatic components and their associated systems in a safe or shutdown mode. The majority of the components stay in the “AS-IS” position and any further operation will require manual manipulation at the discretion of the supervision.

Nitrogen Storage Tank Filling

Liquid nitrogen is delivered to the facility in tanker trucks. The CIF operators need to be aware of the required safety precautions associated with handling liquid nitrogen prior to receiving a delivery. Nitrogen gas acts as an asphyxiant by displacing and diluting oxygen in the air. Because of the extremely low temperature of liquid nitrogen (-320.5° F), severe burns or frostbite can result if contact is made with skin. Safety glasses are required when working in the Liquid Nitrogen Storage Tank Area. The vendor shall be responsible for supplying their own safety equipment and tools to transfer liquid nitrogen into the storage tank.

However, CIF Operations personnel will maintain an extra pair of leather gloves, safety glasses, face shield, ear plugs, and a long sleeve lab coat for vendor use, if needed.

Operators are required to perform the following steps prior to allowing the unloading process to begin:

- Send a liquid nitrogen sample from the vendors truck in a dewar (A glass or metal container that has an evacuated space between the walls used to store or transfer liquefied gasses). The innermost surface is often silvered to prevent heat transfer.
- Ensure vendor's trailer has same number as vendor's Purity Check Sheet
- Verify correct date on Check Sheet
- Ensure Lab results show liquid nitrogen purity is at least 99.5%
- Ensure moisture content < 5 parts per million (ppm)
- Ensure nitrogen is oil free
- Verify vendor's Nitrogen Bulk Product Loading Tag indicates oxygen impurity <10 ppm
- Verify hydrocarbon impurity < 5 ppm
- Ensure vendor unloads nitrogen IAW OSHA regulations, Vendor Safety Rules, and WSRC and CIF Safety Rules and procedures

Operators should also monitor storage tank pressure and level during the delivery to prevent the possibility of rapid pressure changes in the tank, loss of loop seal or hose leaks affecting system operation or personnel safety.

Summary**MODE 1 Normal Operations**

- Plant Air is supplied to the Tank Farm, Offgas, Incinerator, Ashcrete, and Box Handling Areas.
- Instrument Air is supplied to the Tank Farm, Offgas, Incinerator, HVAC, Ashcrete Areas, and the Fire Protection Dry Pipe System.
- Breathing Air is routed from the receiver tank to sixteen stations throughout the CIF.
- Nitrogen System distributes gaseous nitrogen throughout the Tank Farm to four (4) liquid waste tanks and the Fuel Oil tank.

MODE 2 Warm Standby and MODE 3 Cold Standby

- Facility demands from Instrument and Plant Air Systems is reduced or not required.
- The Breathing Air System must remain operational.
- The Nitrogen System must remain operational in both of these modes.

Abnormal Operations

- Alarms or abnormal conditions associated with the Plant Air and Instrument Air include: LOW Plant Air Pressure, Compressor #1 FAILURE, Compressor #2 FAILURE, Instrument Air Dryer FAILURE, and LOW Instrument Air Pressure.
- Abnormal conditions associated with the Nitrogen System include component failure of the nitrogen tank storage and transfer system, nitrogen bottle storage and transfer system, waste tank blanket cover gas systems, or nitrogen snuffing systems.
- Nitrogen pressure in the six bottles may drop to the alarm setpoint of 5 psig as indicated by DCS alarm H-261-FP-PAL-2105. In the event of a low pressure condition, the operators will be required to valve out the on-line bottle and valve in an unused bottle.
- The breathing air system must remain operational during emergency shutdown, as well as during normal incineration system operation.
- Abnormal conditions associated with the Breathing Air System include component failure of the compressor, dryer, header and header isolation valves, local breathing station regulator or filter cartridge, and plugged or cut hoses.
- The actions which an operator takes at the DCS console upon the actuation of any of the above listed abnormal conditions is determined by the approved Abnormal Operating Procedure for Plant Air, Breathing Air or Nitrogen Events.